Pressure-induced phase transitions in $BaGa_2Ge_2O_8:Eu^{3+}$, a potential pressure marker

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Pressure is a fundamental physical parameter that affects all properties of matter, including the internal structure of materials and, therefore, their optical properties. Most luminescent manometers exhibit continuous spectral responses across broad range of increased pressure, limiting precision of pressure determination. Pressure-induced structural phase transition overcomes this limitation by abrupt, discontinuous changes in local symmetry, crystal field strength, and electronic structure, thereby providing well-defined and reliable spectral pressure markers at specific pressure value.[1] The Eu^{3+} ion can be useful optical probes for detecting pressure-induced phase transitions, it combines strong luminescence intensity with exceptional sensitivity of the $^5D_0 \rightarrow {}^7F_j$ radiative transitions to local symmetry changes in the host lattice, thereby enabling precise identification of phase transition pressure through pronounced spectral changes. Pressure-dependent vibrational Raman spectroscopy was employed as a method for structural changes detection, revealing modifications in phonon modes, where emergence or disappearance of modes confirm the pressure-induced phase transition of the host. Next, the luminescence spectroscopy, as a fast and non-invasive method, was employed to observe changes in emission spectra of Eu^{3+} ions with very high precision and accuracy.

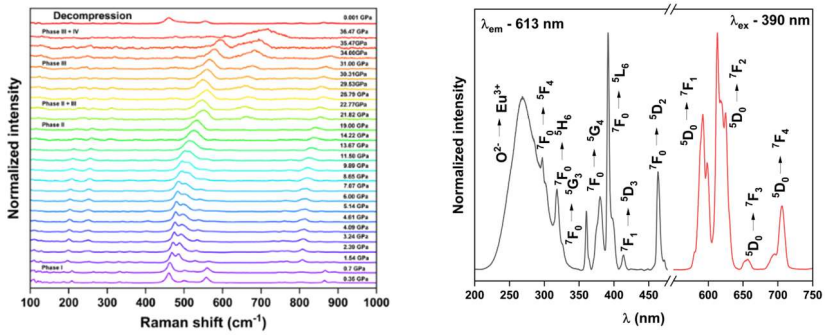

Figure 1: (a) Pressure-dependent Raman spectra (0-36.47 GPa) showing phase transitions, (b) Photoluminescence excitation and emission spectra of $BaGa_2Ge_2O_8:Eu^{3+}$.

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[1]Abbas M. T., Szymczak M., Szymanski D., Drozd M., Chen G., and Marciniak L. (2026) Opt. Mater., 174, 117985.

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